

## **Lesson #33**

### **Topic: Net force in two dimensions**

**Objectives:** (After this class I will be able to)

1. Examine Normal force and observe different situations involving normal force.
2. Solve net force problems involving inclined planes.

**Project:** Describe a situation where the Normal Force acting on an object does not equal the Weight of the object.

Assignment: Transparency 4-4 due tomorrow

# ***Exploring Normal Force***

- Normal force is a force that acts perpendicular to the surface in contact with an object.
- Normal force is **NOT** the opposite of weight.
- Normal force will vary depending on the situation of the object.

# ***Normal Force Examples***

1. If I push on a 1kg book with a force of 100N, I can hold it at rest against the wall.
  - a. Find the weight of the book.
  - b. Find the normal force acting on the book.
  - c. Find the force of friction acting on the book.



# ***Normal Force Examples***

2. I push downward with a force of 100N onto a 1kg book at rest on a table. The book remains at rest.
- a. What is the net force acting on the book? \_\_\_\_\_
  - b. What is the normal force acting on the book?



# ***Normal Force Examples***

3. I lift upward with a force of 5N onto a 1kg book at rest on a table. The book remains at rest.
- a. What is the net force acting on the book?
  - b. What is the normal force acting on the book?



# ***Distribution Company***

- You and a few friends have decided to open a small business called Wee Deliver. The business will guarantee to deliver any box between 5 lbs and 500 lbs to any location in the Twin City area by the next day. At your distribution center, boxes slide down a ramp between the delivery area and the sorting area. In designing the distribution center, you must determine the angle this ramp should have with the horizontal so that a 500-lb box takes 5.0 seconds to slide down the ramp starting from rest at the top. When the box arrives at the bottom of the ramp, its speed should not be too large or the contents of the box might be damaged. You decide that this speed should be 3m/s. Using the latest technology, your ramp will have a very slippery surface so you make the approximation that the frictional force between the ramp and the box can be neglected.

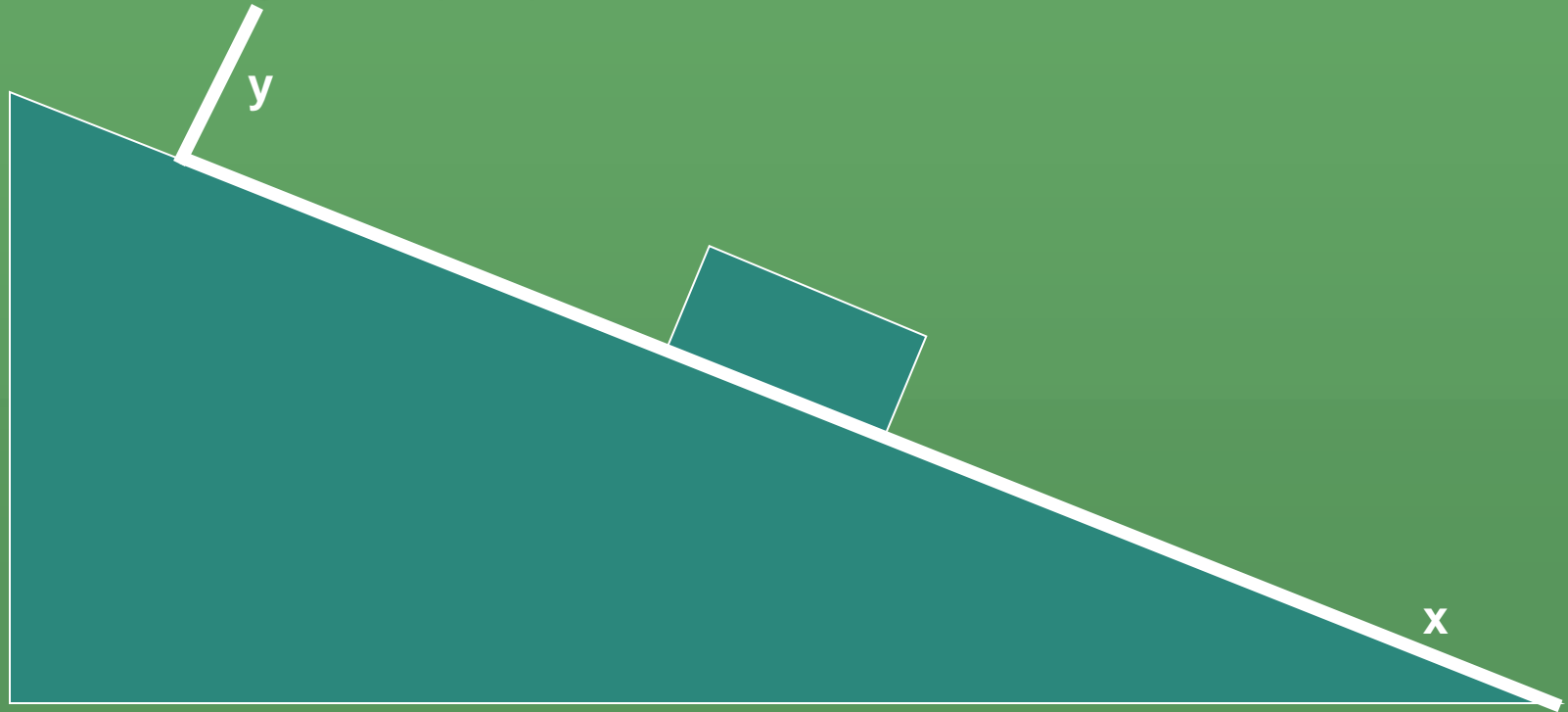


# ***Project***

- Place a cart on a track.
- What happens to the cart when the plane is inclined?
- Draw the cart and inclined plane.
- Draw all of the forces acting on the cart.
- Why does the cart accelerate?
- Explain in terms of forces acting on the cart.
- Assignment: “Concept Devel 5-3 & 5-4”  
due Tuesday

# ***Inclined Planes***

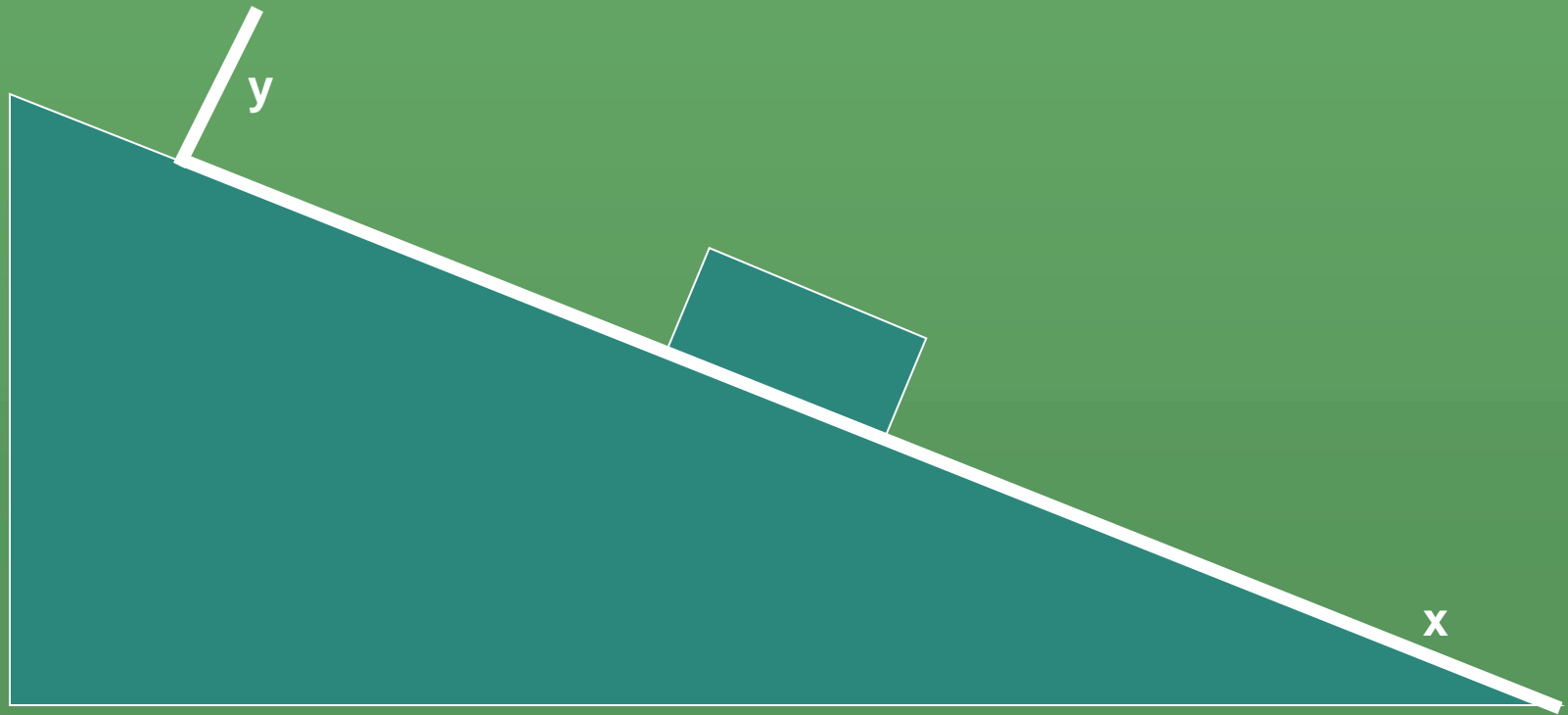
- To best analyze this problem. We will make a new coordinate system.
- With the x axis parallel to the contact surface
- And the y axis perpendicular to the contact surface





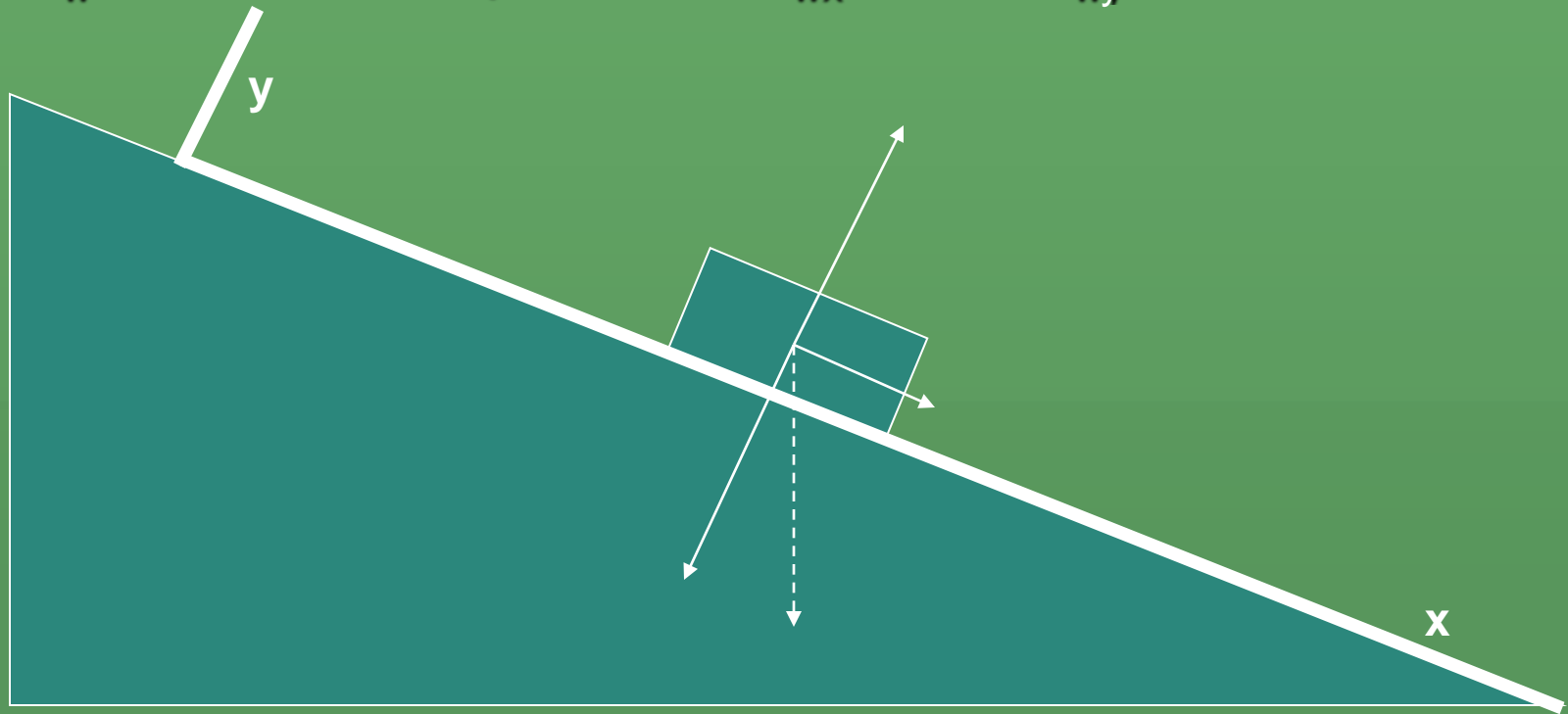
# ***Inclined Planes***

- The only forces acting on the block are its weight and the normal force.
- Since these two forces do not cancel out, the block will accelerate down the incline.



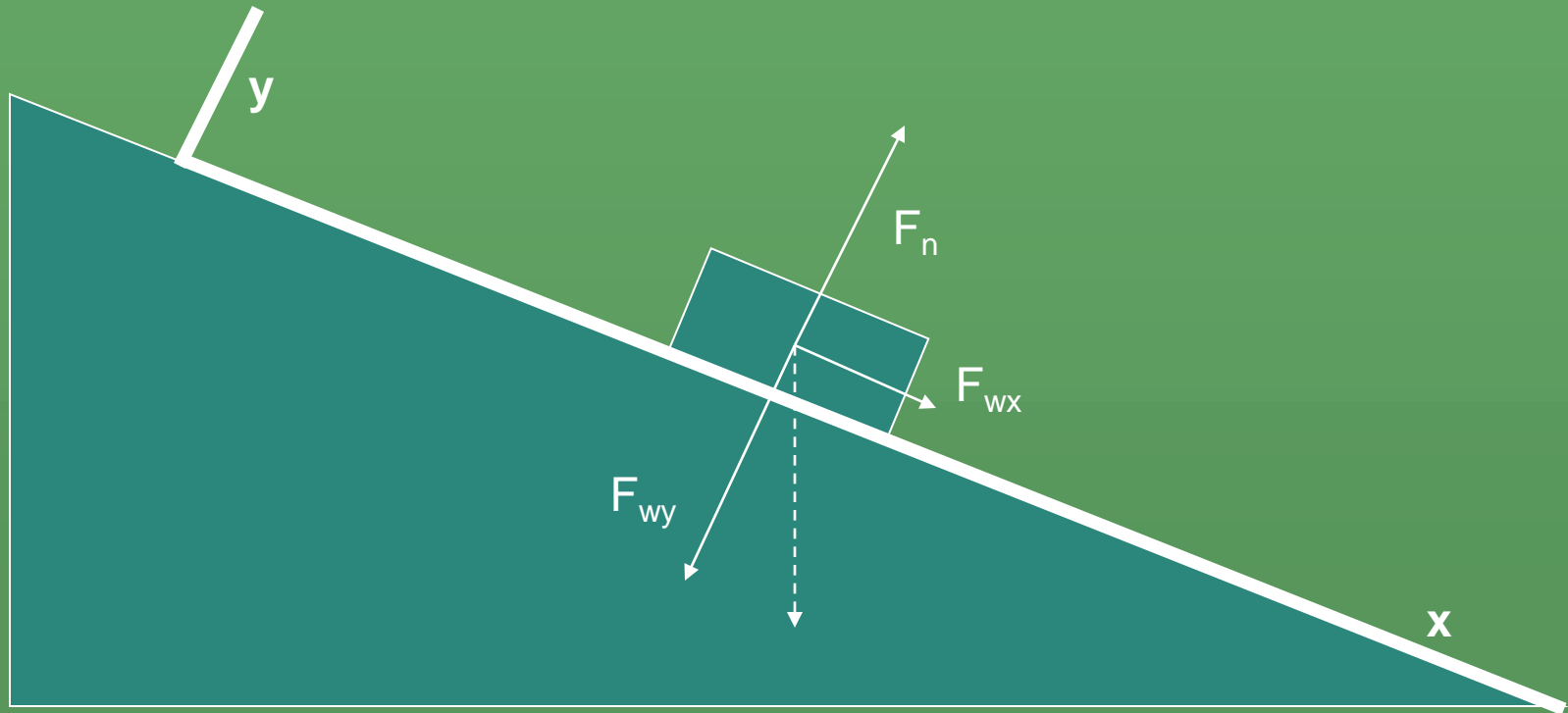
# ***Inclined Planes***

- To find the net force acting on the block, we need to split forces into purely x and y components.
- $F_n$  is completely in the y direction.
- $F_w$  needs to be split into a  $F_{wx}$  and a  $F_{wy}$



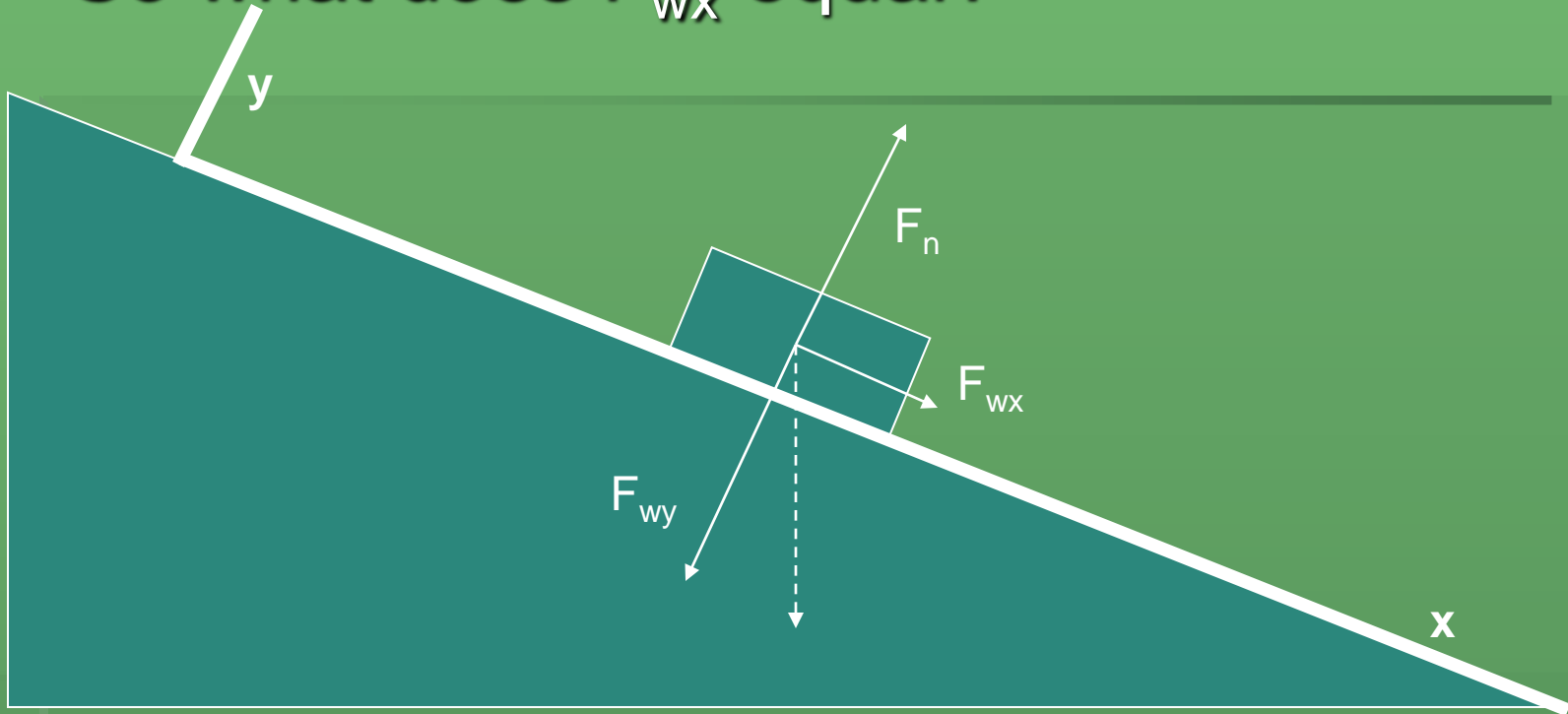
# ***Inclined Planes***

- The block is not accelerating in the y direction so  $F_{\text{net}y}=0\text{N}$
- Therefore  $F_n = F_{wy}$
- The force that is causing the block to accelerate in the x direction is  $F_{wx}$ .
- Therefore  $F_{\text{net}} = F_{wx}$



# ***Inclined Planes (Math)***

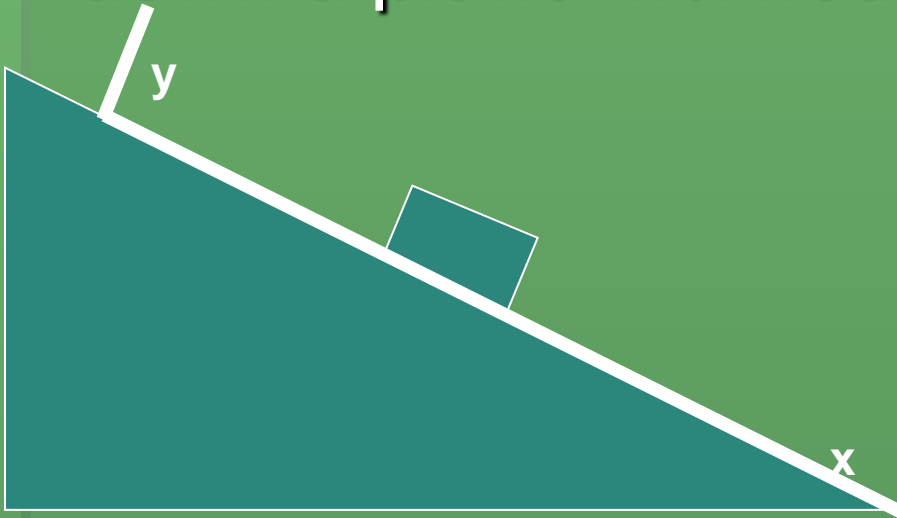
- So what does  $F_{wx}$  equal?



Can you tell me the acceleration of the cart?

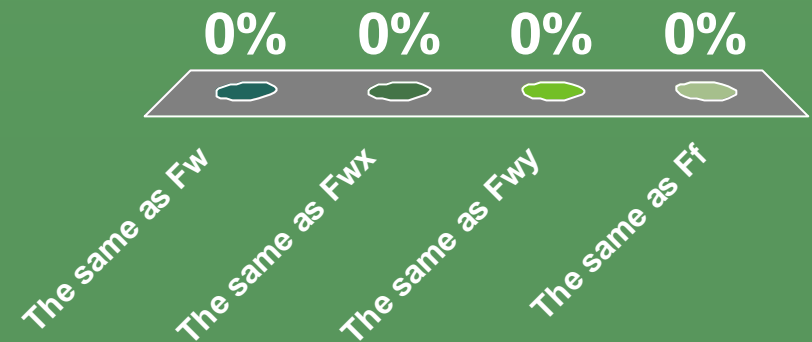
# ***Practice Problems***

1. What is the acceleration of a cart rolling down a plane inclined at  $30^\circ$ ?



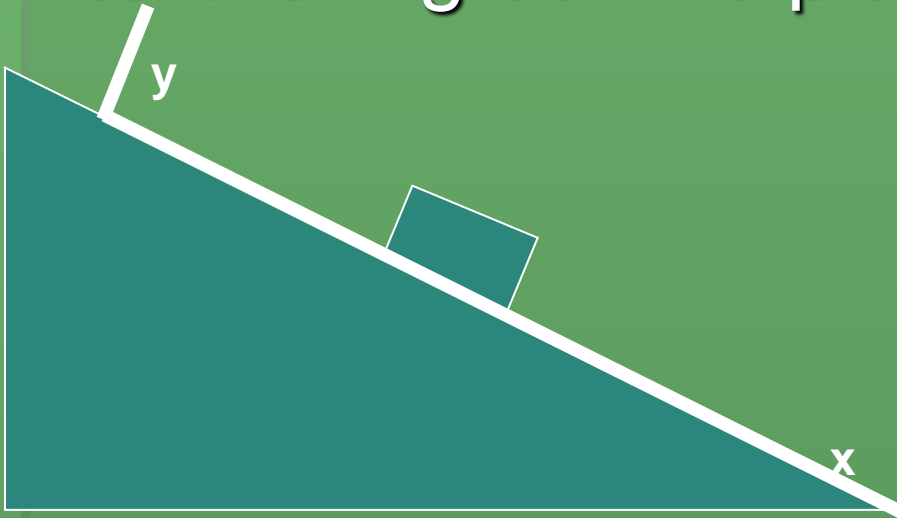
***What is the normal force acting on a 2kg cart rolling down a plane inclined at 30°?***

1. The same as  $F_w$
2. The same as  $F_{wx}$
3. The same as  $F_{wy}$
4. The same as  $F_f$



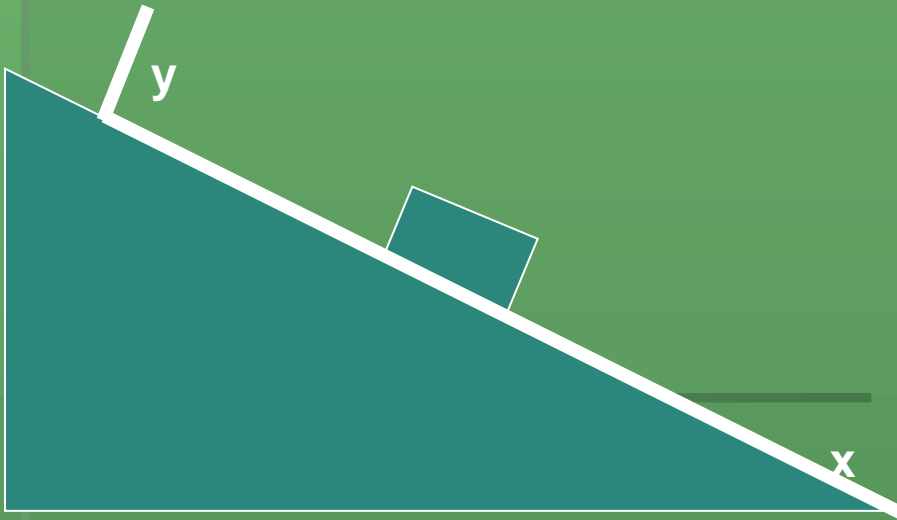
# ***Practice Problems***

2. What is the normal force acting on a 2kg cart rolling down a plane inclined at  $30^\circ$ ?



# ***Practice Problems***

3. A cart is accelerating down an incline at a rate of  $2\text{m/s}^2$ . What is the angle of the incline?





# ***Distribution Company***

- Complete this problem showing all work and explaining your process into finding the angle of the incline.

## **Lesson #34**

### ***Topic: Incline planes and friction***

**Objectives:** (After this class I will be able to)

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- 1.** Solve net force problems involving inclines and friction

**Project:** Observe a wood block at rest on an inclined plane. Discuss with a partner why the block remains at rest? Is there a net force acting on the block? Why or why not?

**Assignment:** New Wikispace post!!!

# ***Force of Friction***

- The force due to friction always opposes the direction that the object wants to move.
- Even if the object is not yet moving.
- Example: I push on the side of a 5kg block with a force of 10N and the block remains at rest. What is the force of friction acting on the block?



# ***Force of Friction***

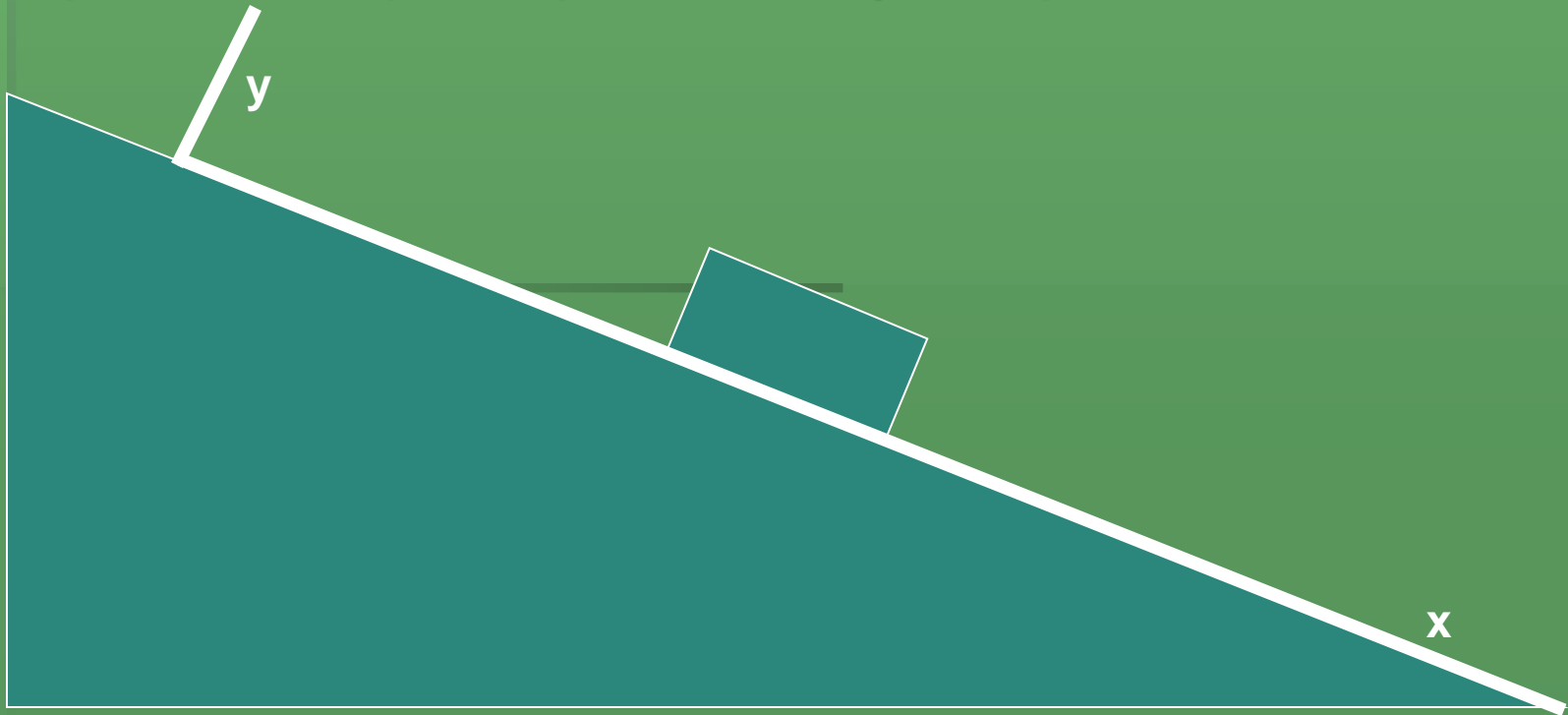
- Example #2: I push on the side of a 5kg block with a force of 10N and the block accelerates at a rate of  $1\text{m/s}^2$ . What is the force of friction acting on the block?



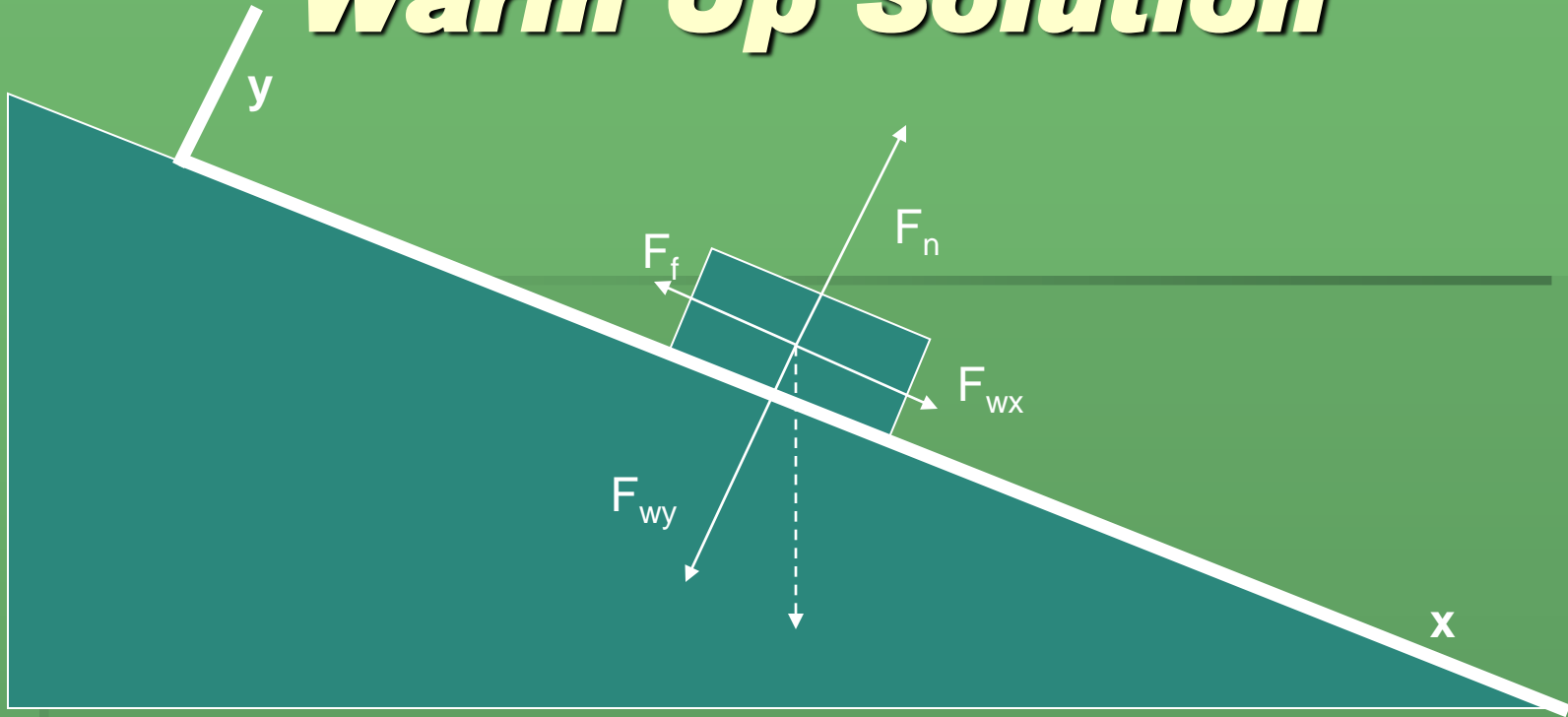
# ***Warm Up***

A 5kg block is at rest on an inclined plane angled at  $30^\circ$  to the horizontal. What is the force of friction acting on the block?

- Draw a picture of the incline and block
- Draw all of the forces acting on the block
- Split forces up into pure x and y components

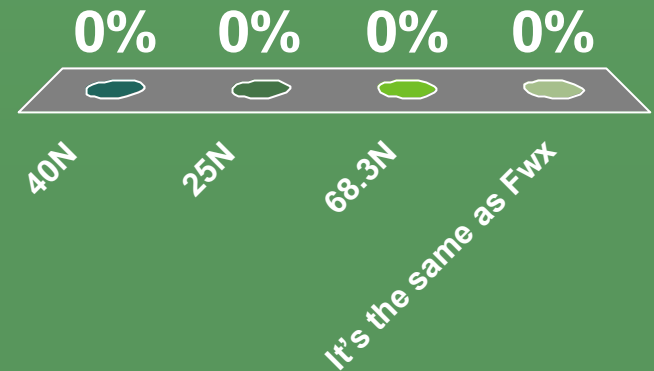


# ***Warm Up Solution***



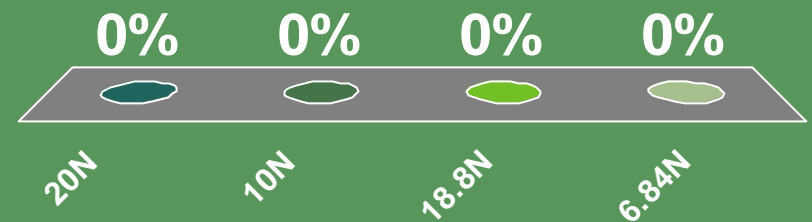
***A block is at rest on an inclined plane angled at  $30^\circ$  to the horizontal. What is the force of friction acting on the block?***

1. 40N
2. 25N
3. 68.3N
4. It's the same as  $F_{wx}$



***A 2kg block slides down a plane inclined at  $20^\circ$  at constant speed. What is the force of friction acting on the block?***

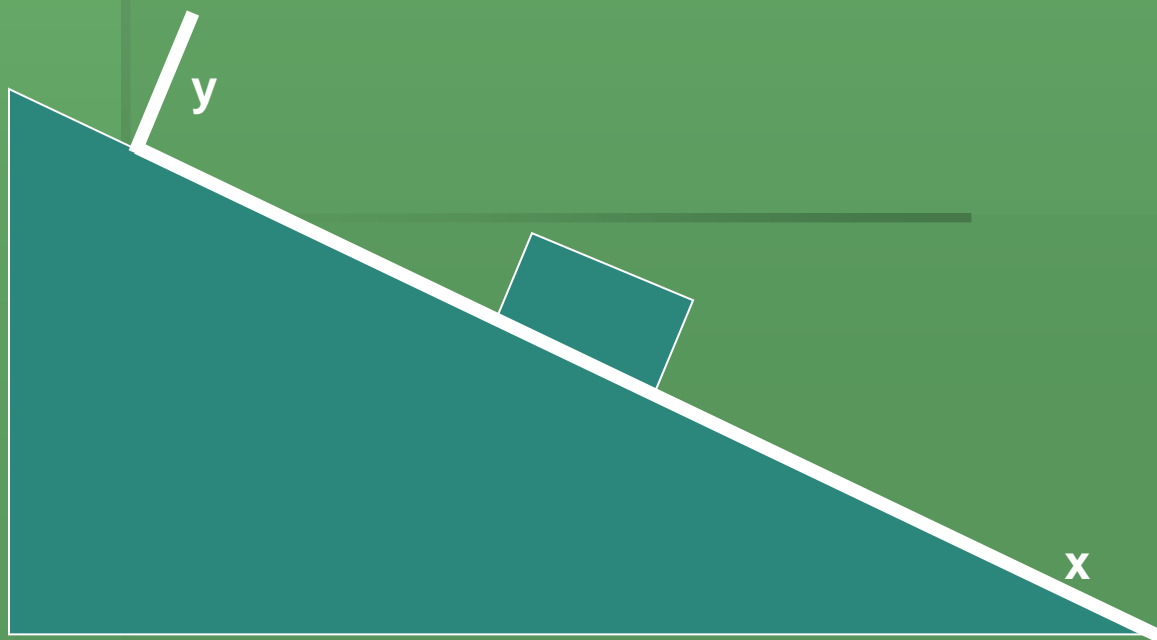
1. 20N
2. 10N
3. 18.8N
4. 6.84N





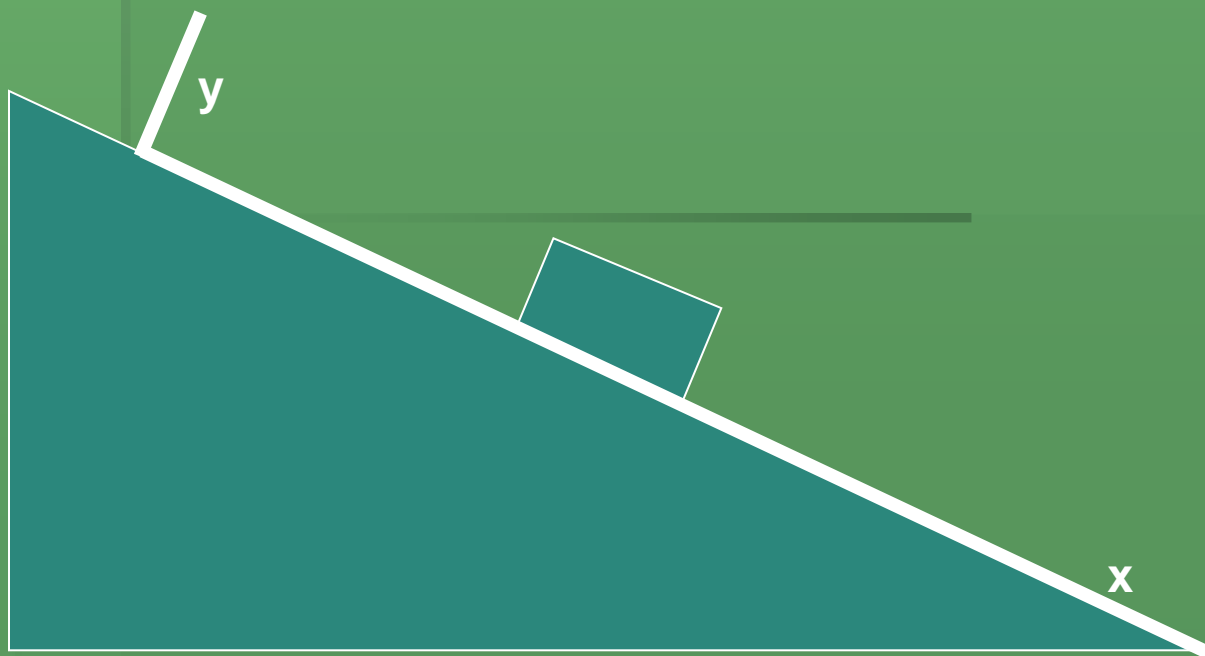
# ***Practice Problems***

1. A 2kg block slides down a plane inclined at  $30^\circ$  with a friction force of 7N acting on the block. What is the acceleration of the block?



## ***Practice Problems***

2. An applied force pulls a 2kg block up a plane inclined at  $30^\circ$  at a constant speed. If the force of friction is still 7N, what is the magnitude of the applied force?



## **Lesson #35**

### **Topic: Lab: Friction Force**

**Objectives:** (After this class I will be able to)

1. Compare the force due to friction acting on objects of different weight, size, and material.
2. Determine what variables affect the force of friction

**Lab Task:** Make predictions about the force due to friction and then collect data to compare calculations to your predictions.

**Lab Question:** What variables affect friction force?

**Assignment:** Lab Report Due at the end of the period Thursday.